# MLF Experimental Report	提出日 Date of Report
課題番号 Project No. 2014B0321	装置責任者 Name of responsible person Takuro Kawasaki, Stefanus Harjo
実験課題名 Title of experiment Dislocation structure and strengthening mechanism in austenitic steel during cyclic tension-compression	装置名 Name of Instrument/（BL No.） BL19 実施日 Date of Experiment 2015/03/26 - 2015/03/28 2015/04/11 – 2015/04/15
実験責任者名 Name of principal investigator Stefanus Harjo 所属 Affiliation JAEA, J-PARC Center	

試料、実験方法、利用の結果得られた主なデータ、考察、結論等を、記述して下さい。（適宜、図表添付のこと）
Please report your samples, experimental method and results, discussion and conclusions. Please add figures and tables for better explanation.

1. 試料 Name of sample(s) and chemical formula, or compositions including physical form.

The sample used in this study was a solution treated 316 type stainless steel. Dog bone shaped specimens with 6 mm diameter in the active part were used in the experiments.

2. 実験方法及び結果（実験がうまくいかなかった場合、その理由を記述してください。）
Experimental method and results. If you failed to conduct experiment as planned, please describe reasons.

This study aims to understand the relation among evolution of dislocation structure, lattice strain and strengthening mechanism during low cyclic tensile-compressive deformation of an austenitic steel. The rod shape 316 stainless steel specimens were tensile-compressive cyclic loaded at different strain amplitude, and the neutron diffraction data was recorded in situ. The cyclic loading tests at the first-second cycles, 1000th and 2000th cycles were done slowly with a strain rate of 1x10^{-5} s^{-1}, to get data with good statistics for dislocation characterization using a convolutional multiple whole profile (CMWP) fitting. The other cycles were done with approximately 0.5 Hz. The applied strain was monitored by a strain gauge pasted on the active part of specimen, and the strain data was used for loading control. The strain amplitude was varied from ±0.1% to ±1.5%. Figure 1 shows the typical history of applied strain during the cyclic test at the strain of ±0.8%.

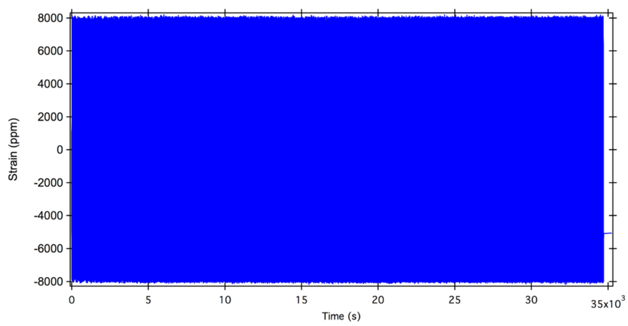

Fig. 1 History of applied strain during cyclic tensile-compressive test at ± 0.8%.

2. 実験方法及び結果（つづき） Experimental method and results (continued)

Figure 2(a) shows the change of load during a cyclic tensile-compressive loading with the applied strain of ±0.8% up to 1000 cycles. When the loads were plotted to the relevant strain, the load-strain curves in Fig. 2(b) was obtained. The load gradually decreased with increasing cycle at the beginning and to be almost constant after 500 cycles.

Figure 2(c) shows the amplitudes of load (delta load) and the average loads during cyclic loading tests at different applied strain amplitudes up to 1000 cycles. The shape of curve was in good agreement to those obtained in low cyclic fatigues of single crystals or large grain polycrystalline metals [1,2], showing that three regions due to the different dislocation structure can be found also in the fine grain polycrystalline 316 stainless steel. That is during low cyclic fatigue with the strain amplitude of less than ±0.2% there might be only dislocation veins, in the region of ±0.2% to ±1.1% where a plateau of load was observed persistent slip bands (PSB) might exist, and in the region of more than ±1.1% dislocation cells might be preferentially formed leading to the early fracture.

To confirm the presence of PSB in the plateau region in Fig. 2(c), the CMWP fitting was performed to the obtained data. Figure 2(d) show the typical measured and CMWP-fitted diffraction patterns of the specimen after 1000 cycles loading test with the strain of ±0.8%. The measured pattern looks well-fitted, but by a careful inspection the tail parts were not well-fitted. For the results, the dislocation densities before and after the cyclic loading of ±0.8% were 6.66×10^{13} and 8.98×10^{13} in m^{-2}, respectively. Those results were close each other and are close to the limit value that can be seen by neutron diffraction. Therefore, it is with regret to know that the instrumental profiles of TAKUMI may not be enough for this study.

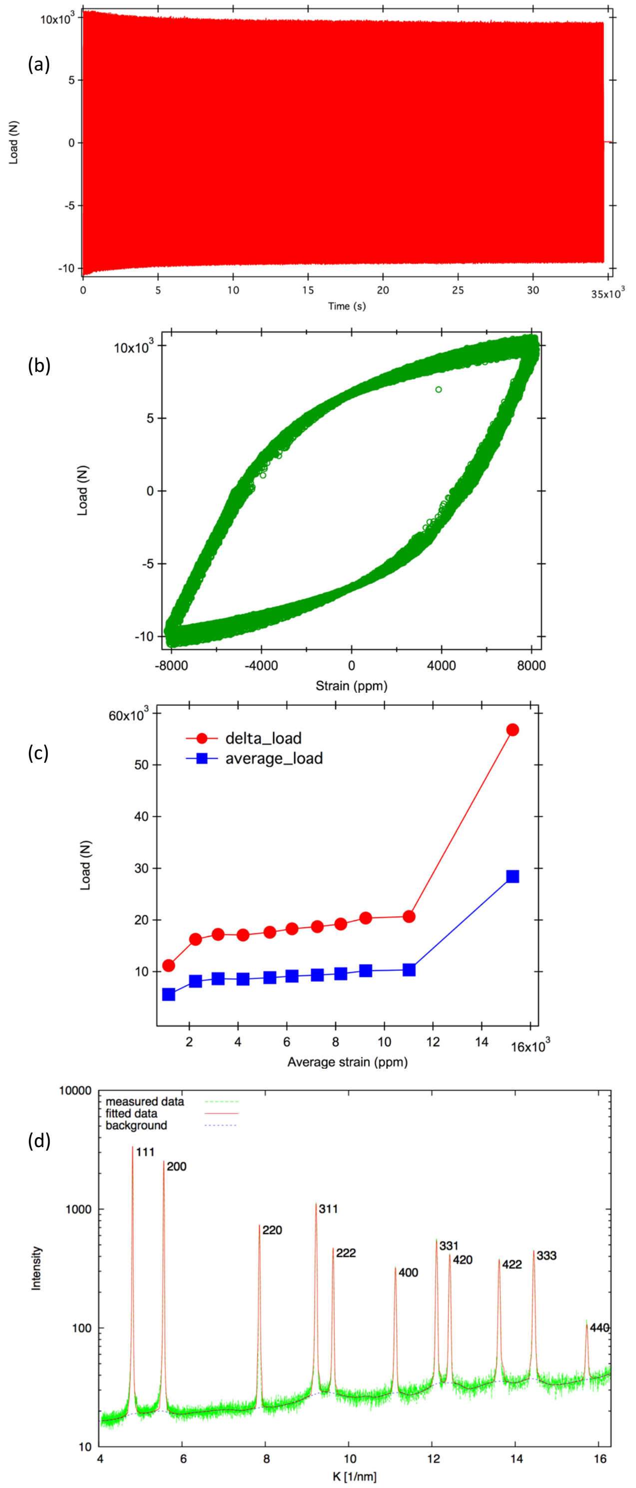

Fig. 2 (a) Change of load and (b) load-strain curves during a cyclic tensile-compressive test at ± 0.8%. (c) Load amplitude and average load as a function of strain amplitude of cyclic tensile-compressive test up to 1000 cycles. (d) Typical measured and CMWP-fitted diffraction patterns of the specimen after the cyclic loading test with ± 0.8%.

Refs.: [1] H. Mughrabi : Mater. Sci. Eng., 33 (1978) 207, [2] P. Lukáš & L. Kunz: Phil. Mag. A, 84 (2004), 317.